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Prediction of pressure evolution with artificial neural network using extended datasets for non-venting liquid hydrogen tanks

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Nowadays, storage of liquid hydrogen (LH2) has become a promising solution to many energy applications compared to conventional fuels. However, self-pressurization phenomenon due to heat leakage into LH2 tanks still represents a bottleneck for its development. Accordingly, accurate prediction of the pressure evolution of LH2 is of great importance and urgent requirement for safe storage, transportation and utilization. As known, storage of LH2 in a tank is a complex multi-physics problem with accompanied thermodynamic phenomena and complicated fluid-fluid and solid-fluid interactions resulting from heat and mass transfer processes. Due to such complications, thermodynamic homogeneous model (THM) cannot alone capture the complex hidden features and characteristics of LH2 self-pressurization phenomenon. Consequently, THM cannot provide accurate predictions of the pressure evolution in non-venting LH2 tanks. In the present work, artificial neural network (ANN) as an intelligent approach will be integrated with THM to give a whole picture about LH2 self-pressurization phenomenon based on the combined experimental and theoretical basis. More clearly, based on extended datasets from THM as well as the experimental data, one accuracy-improved ANN model is developed using MATLAB software to improve the prediction ability of both the thermodynamic homogeneous model solely as well as the normal ANN model established alone based on the experimental data. Compared to the normal ANN model, the improved ANN model based on the thermodynamics theory from THM has achieved a maximum improvement of over 20 % in the average prediction error, when applied to one established LH2 tank from literature work. This research provides an effective approach based on the ANN methodology combined with one theoretical model to improve the prediction of pressure evolution in LH2 tanks. The integration of artificial intelligence techniques based on experimentations into the theoretical basis from thermodynamic models holds great potential as a promising avenue for future research.

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